Description

Arrangement for Measuring the Geometry or Structure of an Object

The invention relates to an arrangement for measuring the geometry or structure of an object by means of a coordinate measuring device with an optical system for capturing and imaging a measuring point of at least one optical sensor such as CCD (charge-coupled device) sensor, whereby the optical system comprises at least one movable lens group consisting of measuring lenses and at least some of the measuring lenses are held by one seat.

For employment in image processing systems for measuring technology, zoom lenses are particularly suitable as imaging systems. In this connection, systems are known in which only the enlargement can be adjusted, as well as systems in which both enlargement and working distance can be adjusted (DE 198 16 220 7.52).

In employing such systems, it is also necessary to achieve vertical lighting from above of the objects to be measured. In so-called bright field epi-illuminator lighting, this takes place through reflection of an illumination beam path into the zoom lens system. This often brings the disadvantage that illumination light reflections occur on individual optical contact surfaces, and therefore stray light in the imaging beam path deteriorates the image quality. To prevent this, the lighting can be arranged separately. As a consequence, the lighting intensity and the size of the lighting spot are not adjusted to the respective magnification of the zoom lens system.

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Systems are also known, in which distance sensors, such as laser distance sensors, are also integrated into the optical system (DE 100 49 303 A1, DE 38 06 606 C2). Here too, it is difficult to optimize the optical properties of the zoom lens system to the image processing requirement, as well as to the laser sensor technology. On the other hand, this problem is partially solved by separate in-reflection, though with the associated disadvantage of lesser flexibility, since no adjustment corresponding to zoom takes place.

DE 100 56 073 A1 as well as US-A 4,277,130 relate to stereo zoom lens systems. Optical systems are thereby aligned to each other in such a way, that the beam paths passing through each partial system are aligned to each other at an acute angle, focused on a common sharp point.

The objective of the present invention is to prevent the aforementioned disadvantages, and to provide an arrangement in which optimization of the lighting occurs, while preventing any interfering reflections.

According to the invention, the problem is solved in principle in that in some of the seats holding the measuring lenses of the at least one movable lens group, at least one additional lens is arranged for imaging a light beam onto the object, whereby a first beam path originating from the measuring lenses runs parallel on the object side to the second beam path originating from the at least one additional lens.

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They show:

Fig. 1 a first embodiment of a lens system;

Fig. 2 a second embodiment of a lens system, and

Fig. 3 a schematic diagram of a coordinate measuring device.

Fig. 3 schematically shows a coordinate measuring device 100 with a base frame 2 consisting, for example, of granite. On this, a measuring table 104 is arranged, on which there is a non-workpiece 105, which has to be measured.

Along the base frame 102, a portal 106 is movably arranged in the Y-direction of the coordinate measuring device 100. For this purpose, columns or stands 108, 110 are movably supported on the base frame 102. From the columns 108, 110, a traverse 112 originates, along which, a slide 114 is movably arranged, that is, in the X-direction of the coordinate measuring system in the embodiment, which in turn seats a sleeve or column 116, which can be adjusted in the direction of the Z axis. From the sleeve or column 116, or from an alternating intersection point, a sensor system 118 originates, which is described in more detail in Fig. 1 and 2, in order to measure the workpiece 105 arranged on the measuring table 104.

Correspondingly, in the embodiment of Fig. 1, the sensor system 118 comprises a first lens group 10 and a second lens group 12. Each lens group 10, 12 has several lenses 14, 16, or 18, 20, or 22, 24, whereby several lenses each originate from a common seat 26, 28, 30. In the embodiment, lenses 18,20 originate from seat 26, lenses 14, 16 from seat 28, and lenses 22, 24 from seat 30. If only two lenses per seat are shown in the embodiment, there might also exist more than two lenses in each seat according to the requirements.

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The lenses 14, 16, 18, 20, 22, 24 contained in seats 26, 28, 30 are aligned to each other in such a way, that beam paths running parallel to each other can be formed. Thus, according to Fig. 1, the lenses 14, 18, 22 are arranged in a first row, and the lenses 16, 20 24, in a second row, with common optical axis 32, 34 each. Thereby, the lenses 14, 18, 22 are designed with a zoom lens system, to measure an object 38 – in the illustration of Fig. 3, the workpiece 38 – by means of an optical sensor such as CCD sensor 36 or camera. The seats 26, 28 can be adjusted, as is indicated by the arrows.

In order to be able to measure the object 38 in bright field epi-illuminator lighting, a light source 38 is arranged to the lenses 16, 20 24 aligned along the optical axis 34. The beam going through the lenses 24, 16, 28 is then deflected onto the object 38 via a mirror 40 and a beam splitter 24, as well as an additional fixed lens 44 running on the object side. Thus, the light beam originating from the light source 38 and the beam necessary for measuring by means of the CCD sensor impinge on the same measuring point of the object 38.

The embodiment of Fig. 2 differs from the one in Fig. 1, in that a beam 46 running parallel to a measuring beam 44 outside of lenses, is deflected – in the embodiment – via a mirror 48 as well as a beam splitter 50 into the optical beam 44. Thus, the light beams 44, 46 impinge on the same spot 52 of an object 54. In the embodiment of Fig. 2, the measuring beam runs along an optical axis 56 of lenses 58, 60, 62, 64, which are focused on an optical sensor such as a CCD sensor 66. Furthermore, lenses 58, 60, 62, 64 originate from seats 68, 70, 72, 74, in which lenses 76, 78, 80, 82 are arranged, via which the beam 46 is imaged. The lenses 76, 78, 80, 88 may be intended for a bright field epi-illuminator lighting or a laser distance sensor.

The seats 70, 72 are adjustable (see arrows).

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The disadvantages inherent in the state of the art, in particular the undesirable scattered light or light reflections, are avoided by the theory of the invention, and various requirements can be met with various lens groups without any additional mechanical expenditure. What is more, the lenses 58, 76, or 64, 68 originating from the seats 68, 74 are arranged fixed, and the lenses 60, 78, or 62, 80 originating from the seats 70, 72 are arranged movably to each other, to be able, for example, to be able to change magnification or working distance to the desired extent. Measurements are integrated with a laser distance sensor, or for a bright field epi-illuminator lighting measurement, without having to forfeit anything with respect to the quality.

The processing of the images resulting from the sensor 36 is done in the usual way. Thus, the images taken by the CCD sensor 36 may, for example, be digitized in an interface card in a computer. The image is then available on the computer, to be able to access for image processing purposes. These include numerical procedures for simple image enhancement, such as noise reduction, or increase in contrast, as well as more complex procedures for automatic feature extraction or pattern detection. The image processing computer may be, depending on the requirements, a PC, a workstation, or a parallel computer architecture.

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Patent Claims

1. Arrangement for measuring of the geometry or structure of an object (38) by means of a coordinate measuring device (100) with an optical system for capturing and imaging a measuring point on at least one optical sensor (36), such as CCD sensor, whereby the optical system consists of at least one movable lens group containing measuring lenses (14, 18, 22, 58, 60, 62, 64), and whereby at least some of the measuring lenses are each held by a seat (26, 28, 30, 68, 70, 72, 74), characterized in that in at least some of the seats (26, 28, 30, 68, 70, 72, 74) holding the measuring lenses (14, 18, 22, 58, 60, 62, 64) of at least one movable lens group, at least one additional lens (16, 20, 24, 76, 78, 80, 88) is arranged for imaging a light beam onto the object (38), whereby a first beam path originating from the measuring lenses runs on the object side parallel to the second beam path originating from the at least one additional lens.

2. Arrangement according to claim 1, characterized in that the first beam path is an image processing beam path and/or the second beam path is a lighting beam path of a bright field epi-illuminator or a laser distance sensor beam path.

3. Arrangement according to claim 1 or 2, characterized in that the first and the second beam path, and possibly one further beam path going through lenses arranged in the seats (26, 28, 30, 68, 70, 72, 74), impinge on or to a certain extent on one point of the object (38).

4. Arrangement according to at least one of the preceding claims, characterized in that in each seat (26, 28, 30, 68, 70, 72, 74) of the measuring lenses (14, 18, 20, 58, 60, 62, 64) of the movable lens group, at least one additional lens (16, 20, 24, 76, 78, 80, 88) is arranged as imaging lens.

5. Arrangement according to at least one of the preceding claims,

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characterized in that in front or behind a movably arranged additional measuring lens (44) on the object side, a second beam path originating from the additional lenses (16, 20, 22) can be deflected into the optical axis (32) of the measuring lenses (14, 18, 22).

6. Arrangement especially according to claim 1 with an imaging lens system with zoom lens system comprising lenses arranged in seats, which can be adjusted in relation to each other for magnification and/or working distance change, characterized in that each seat holds lenses for two or more beam paths running in parallel to each other.

7. Arrangement according to at least claim 6, characterized in that the measuring lenses (14, 18, 22, 58, 60, 62, 64) passed through by the image processing beam path, and/or the additional lenses (16, 20, 24) passed through by the lighting beam path, and/or the lenses (76, 78, 80, 88) passed through by the laser distance beam path are optimized with respect to this light passing though them.

8. Arrangement according to at least claim 1, characterized in that the lenses are coated for achieving an optimization of the beams passing through them.

9. Arrangement according to at least one of the preceding claims, characterized in that in the seats (26, 28, 30, 68, 70, 72, 74) lenses (14, 16, 18, 20, 22, 24, 58, 60, 62, 64, 76, 78, 80, 88) are arranged, which fulfill requirements of an image processing lens system, as well as requirements of a laser distance sensor, and also requirements of a bright field epi-illuminator lighting.

10. Arrangement according to at least one of the preceding claims, characterized in that respective lenses passed through by a beam path, and/or lenses passed through by the beam paths, each have the same optical

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properties.

11. Arrangement according to claim 10, characterized in that the lenses as a function of the color of the light passing through them are optimized by means of antireflective coating.

12. Arrangement according to at least one of the preceding claims, characterized in that the lenses (14, 18, 22, 58, 60, 62, 64) passed through by the image processing beam path have high-quality optical properties, and the additional lens or lenses have lower quality optical properties with fundamentally the same nominal parameters.

13. Arrangement according to at least one of the preceding claims, characterized in that the beam paths passing through the lenses (14, 16, 18, 20, 22, 24, 58, 60, 62, 64, 76, 78, 80, 88) are combined on the object side into a common beam path by means of a mirror system.

14. Arrangement according to at least one of the preceding claims, characterized in that in addition to the movable seats (26, 28, 30, 68, 70, 72, 74) holding the lenses (14, 16, 18, 20, 22, 24, 58, 60, 62, 64, 76, 78, 80, 88), a movable aperture is integrated, which is so arranged at the respectively required location for the adjustment of the objective, that a telecentric optical system is realized.

15. Arrangement according to at least one of the preceding claims, characterized in that a telecenter aperture is arranged in the optical beam path, which can be moved into and out as needed.

16. Arrangement according to at least one of the preceding claims, characterized in that a telecenter aperture can effectively be introduced in the beam path by opening or closing.

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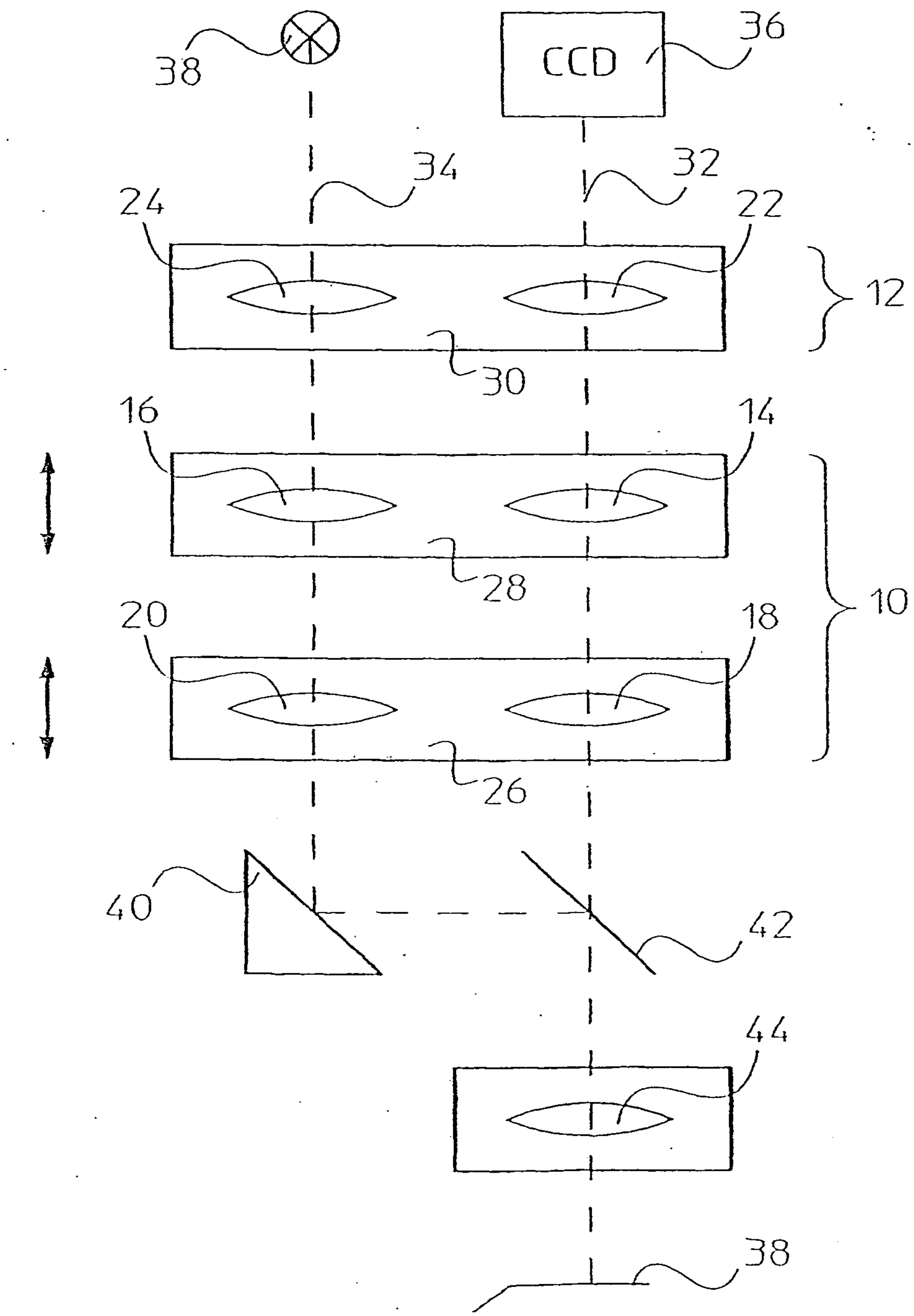

Fig. 1